Variable Property Fluids for Dynamic Environmental Thermal Control

Completed Technology Project (2012 - 2012)

Project Introduction

Often in developing a thermal control system for environment control and life support systems a heat transfer fluid is selected on the basis of compromises between its heat transfer characteristics, operating range, and safety, among other parameters. The resulting choice is often a mediocre fluid with less than ideal performance or a complicated multi-fluid system. This study seeks to establish the merit of a fluid system having dynamic fluid properties, and whether better performance can be had from a dynamic fluid. Specifically, this study considers a representative water-based solution as the working fluid in a system where fluid properties are adjusted in response to the thermal environment and identifies whether turn-down ratio for heat rejection can be improved.

Spacecraft designed to meet current safety standards use a two-loop thermal control architecture. This project explores the merit of dynamic fluids as a technology to enable single loop architecture. A dynamic fluid is a solution or suspension where the composition is adjusted to tailor fluid properties throughout a mission to a spacecraft's environment. Often in developing a thermal control system for environment control and life support systems a heat transfer fluid is selected on the basis of compromises between its heat transfer characteristics, operating range, and safety, among other parameters. The resulting choice is often a mediocre fluid with less than ideal performance or a complicated multi-fluid system. This study seeks to establish the merit of a fluid system having dynamic fluid properties, and whether better performance can be had from a dynamic fluid. Specifically, this study considers a representative water-based solution as the working fluid in a system where fluid properties are adjusted in response to the thermal environment and identifies whether turn-down ratio for heat rejection can be improved. This study modeled a conventional single loop vehicle thermal control system with a dynamic fluid in one case and a static fluid in another. The dynamic fluid was modeled over a range of compositions where the static fluid contained a representative constant composition. The results of this model show up to a 17% improvement in turn-down with the selected fluid. This enhancement becomes single-loop enabling when employed in conjunction with variable heat rejection technology. Thermal desktop modeling of a simple vehicle thermal control system with freezable (also known as stagnating) radiator technology indicates that system turn-down can be improved significantly, approaching a 6:1 system turndown through to the lower freezing point of the dynamic fluid.

Anticipated Benefits

This technology promises mass and volume savings by enabling a single loop thermal control architecture.

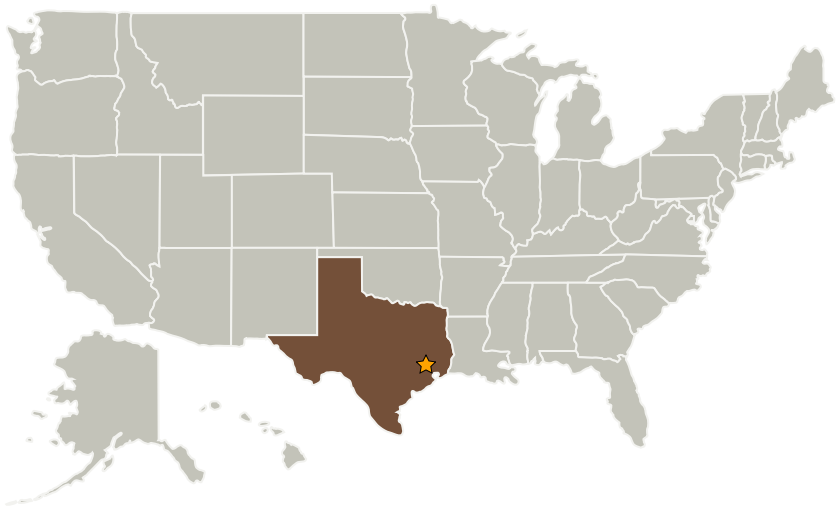
Variable Property Fluids for Dynamic Environmental Thermal Control

Table of Contents

Variable Property Fluids for Dynamic Environmental Thermal Control

Completed Technology Project (2012 - 2012)

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Johnson Space Center(JSC)	Lead Organization	NASA Center	Houston, Texas
Jacobs Engineering Group, Inc.	Supporting Organization	Industry	Dallas, Texas

Primary U.S. Work Locations
Texas

Links

NTR 1
(http://MSC-25703-1)

Organizational Responsibility

Responsible Mission Directorate:
Space Technology Mission Directorate (STMD)

Lead Center / Facility:
Johnson Space Center (JSC)

Responsible Program:
Center Innovation Fund: JSC CIF

Project Management

Program Director:
Michael R Lapointe

Program Manager:
Carlos H Westhelle

Project Manager:
Thomas J Cognata

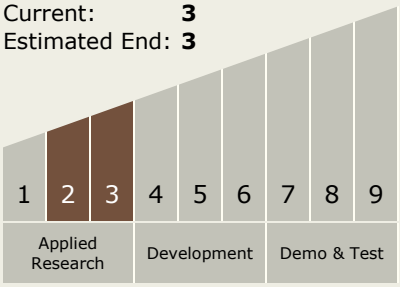
Principal Investigator:
Thomas J Cognata

Variable Property Fluids for Dynamic Environmental Thermal Control

Completed Technology Project (2012 - 2012)

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX14 Thermal Management Systems
  - TX14.2 Thermal Control Components and Systems
    - TX14.2.3 Heat Rejection and Storage